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A STUDY OF FIVE NEW ENGLAND SPECIES OF SCAPANIA[1]

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THE writer in 1930 discussed "three species of *Scapania* from western North America" (**6**) from the standpoint of the ideas expressed in Buch's recent monograph on the Scapaniaceae of northern Europe and Siberia (**4**). The same method is employed in the present paper, which considers five species of *Scapania* from New England. The species in question are *S. gymnostomophila*, *S. apiculata*, *S. curta*, *S. mucronata*, and *S. lingulata*. These species are by no means confined to New England but have an extensive distribution, for the most part circumboreal.

The family Scapaniaceae, as defined by Buch (**4**, p. 10), includes the following genera: *Douinia* Buch, *Diplophyllum* Dumort., *Scapaniella* Buch, *Scapania* Dumort., and *Blepharidophyllum* Ångstr. Of these genera *Douinia*, with the single species *D. ovata* (Dicks.) Buch, is confined in North America to the Pacific Coast region, and *Blepharidophyllum* is distinctly antarctic. The other three genera are all found in New England. The distinctions between *Scapania* and *Scapaniella*, represented in North America by *S. glaucocephala* (Tayl.) Evans, will be commented upon by the writer in another connection. Those between *Diplophyllum* and *Scapania* may now be briefly reviewed.

In most recent works on the Hepaticae the main distinctions between these genera are drawn from the perianth. This organ, in typical species of *Scapania*, is strongly compressed, with sharp lateral

[1] Contribution from the Osborn Botanical Laboratory.

keels; the dorsal and ventral surfaces, moreover, lack supplementary folds, and the mouth is not contracted. In *Diplophyllum*, on the other hand, the perianth is less strongly compressed and is bounded laterally by rounded folds, additional dorsal and ventral folds are present (at least in the upper part), and the mouth is distinctly contracted. In Buch's monograph the main distinctions between these two genera are drawn from the leaves. In typical *Scapaniae* these are keeled throughout; in other words the two lobes meet at a definite angle, which is most clearly shown by cross-sections. In *Diplophyllum*, however, the leaves, although keeled above, are not keeled below, and a cross-section shows a broad open curve. The unkeeled portion extends about half-way to the sinus between the lobes and forms a more or less distinct sheath around the stem.

In most of the species belonging to the genera in question the *Scapania* type of leaf is associated with the *Scapania* type of perianth and the *Diplophyllum* type of leaf with the *Diplophyllum* type of perianth. There are a few species, however, in which the *Scapania* type of leaf is associated with the *Diplophyllum* type of perianth, and these have sometimes been referred to *Scapania* and sometimes to *Diplophyllum*. Buch refers all such species to *Scapania* but separates them subgenerically from the more typical members of the genus. The only New England species falling into this doubtful category is *S. gymnostomophila*, for which Buch proposes the new subgenus *Kaalaasia*, named in honor of B. Kaalaas, the author of the species. All the other species of *Scapania* found in New England are referable to his subgenus *Euscapania*.

One of the most noteworthy features of Buch's work on *Scapania* (**3**) is his use of pure culture methods. By cultivating certain species under varying conditions of light and water-supply he has been able to show that marked differences in the appearance and structure of the plants may be directly due to differences in these external factors. Many types of *Scapaniae*, which represent such responses to the environment, occur in nature, and some of these have been distinguished in the literature, sometimes as forms, sometimes as varieties, and sometimes even as distinct species. Buch, however, would apply the term "modification" to all such environmental fluctuations and would not regard them as definite taxonomic entities. He would reserve the terms form, variety, and species for types transmitted by heredity and therefore essentially different from environmental responses. As examples of his modifications, which are more or less

alike in different species, it will be sufficient to mention "mod. *viridis*," with leaf-cells having colorless cells-walls, caused by diffuse light; "mod. *colorata*," with leaf-cells having pigmented cell-walls, caused by exposure to direct sunlight; "mod. *leptoderma*," with thin-walled leaf-cells, caused by a complete (or almost complete) absence of transpiration; and "mod. *pachyderma*," with thick-walled leaf-cells, caused by excessive transpiration.

Buch's work emphasizes further the importance of certain histological features of the stem and leaves in distinguishing species. In the stem, as seen in cross-section, a small-celled cortex, varying in different species from one to five cells in thickness, and a large-celled medulla can be distinguished. The cells of the cortex may be thin-walled or thick-walled, according to the environment, and any deposits of thickening lining the cell-cavities are more or less uniform. The cells of the medulla are usually thin-walled throughout but occasionally show minute thickenings at the angles. In the leaves a marginal band, one or more cells wide, is characteristic of certain species. The cells of this band, in its most usual development, have uniformly thickened walls and thus stand in contrast to the interior cells, which have localized thickenings at the angles. Unfortunately bands of this character, although distinctive of certain species, are not necessarily of constant occurrence. In the variable *S. undulata* (L.) Dumort., for example, well-marked bands are present in mod. *pachyderma*, but in the submerged and more usual mod. *leptoderma* the leaf-cells are thin-walled throughout.

Of the cell-contents Buch emphasizes the importance of the fat-bodies from the standpoint of the taxonomist and notes that their development is but little influenced by external factors. The fat-bodies, when different species are compared, show differences in size, in color, and in the number present in each cell. In most cases fresh material is necessary for their study, since they tend to disintegrate after death and often disappear completely. In a few species, however, they are more persistent and can be demonstrated even in old herbarium specimens.

The five species to be discussed are among the smallest members of the genus. As already noted Buch places *S. gymnostomophila* in the subgenus *Kaalaasia* and the other four species in the subgenus *Euscapania*. Of these four species *S. apiculata* is referable to Buch's section *Apiculatae*, and *S. curta*, *S. mucronata* and *S. lingulata* to his section *Curtae*. Eight additional species of *Scapania* have been found

in New England, and these illustrate four of Buch's other sections of *Euscapania.*

1. SCAPANIA GYMNOSTOMOPHILA Kaalaas, Bot. Not. **1896**: 21. *Diplophyllum gymnostomophilum* Kaalaas, Vidensk.-Skrift. I. **1898**[9]: 4–9. *f. 1–4.*

In calcareous regions, mostly on limestone cliffs in association with other bryophytes.

MAINE: Round Mountain Lake and vicinity, Franklin County, 1916 (*Miss Lorenz*), listed in Rhodora **19**: 272. 1917, as *Diplophyllum gymnostomophilum.*

VERMONT: Rochester, 1910 (*Dutton*), determined by Buch, listed in Rhodora **14**: 224. 1912, as *Scapania curta;* Willoughby, 1913 (*Miss Lorenz*), listed in Rhodora **16**: 72. 1914, as *Diplophyllum gymnostomophilum;* same locality, 1917 (*Miss Lorenz*); Smuggler's Notch, 1917 (*Miss Lorenz*); Quechee Gulf, Hartford, 1921 (*Miss Lorenz*).

The following North American stations outside New England may also be cited:— ELLESMERE LAND: Havnefjord and Isachsens Fjord, King Oscar Land, 1898–1902 (*Simmons*), listed by Bryhn in Report Second Norwegian Expedition in the "Fram" **11**: 47. 1906, as *Diplophyllum gymnostomophilum.* NOVA SCOTIA: Middle Harbor, Dingwall, 1917 (*Nichols*). WISCONSIN: Black River, Douglas County, no date (*Conklin*). The species is widely distributed in northern and central Europe and also in Siberia.

The writer (**6,** p. 71) has already called attention to some of the more important features of this interesting species and to the divergent views which have been held regarding its systematic position. As already noted Buch places it in *Scapania,* rather than in *Diplophyllum,* because its leaves do not conform to the *Diplophyllum* type. The monotypic subgenus *Kaalaasia,* which he proposes for its reception, is characterized not only by its plicate perianth but also by its small dorsal lobes, which rarely extend to the upper margin of the ventral lobes; and by its peculiar fat-bodies, which are brownish and unusually large for the genus. In most cases these fat-bodies occur singly in the leaf-cells and occupy the greater part of the cell-cavity. It is only along the margin, toward the bases of the lobes, and in the apical portions of gemmiparous leaves that they are sometimes found in pairs or clusters. The fat-bodies persist for a long time in herbarium specimens but eventually disappear.

Buch emphasizes also, as a subgeneric character, the entire margins of the leaves and states that this condition prevails even in the case of gemmiparous leaves. In the subgenus *Euscapania,* on the other hand, many of the species have toothed leaves, and even those in

which the lobes are normally entire tend to develop teeth on the leaves of gemmiparous branches. Apparently, however, Buch lays undue emphasis on this particular difference, since the leaves of *S. gymnostomophila* are not invariably entire. In the writer's experience minute denticulations, each consisting of a single projecting cell, are occasionally produced and seem to be associated in some way with the production of gemmae. These denticulations, which have been observed in both European and American material, may have thin walls, but in other cases their walls are thickened and thus resemble the outer walls of ordinary marginal cells. Although in most of the plants examined an individual leaf rarely produces more than one or two denticulations, some of the leaves in the Nova Scotia plants produce from four to eight.

The leaf-lobes in *Kaalaasia* are usually pointed, although the ventral lobe in some cases is rounded. The point consists of a single cell or in rare instances of two cells, and the outer wall is either thin or thickened, thus resembling the outer walls of the marginal denticulations. Buch describes the leaf-cells as everywhere "collenchymatous." The trigones, however, as shown by his figures, usually have concave sides and may be minute and indistinct. According to Kaalaas (**8**, p. 5) the cortex of the stem is composed of two or three layers of cells with thickened brownish walls. According to Buch the cortex consists of a single layer of flattened cells with uniformly thickened walls, which are distinctly smaller than the medullary cells, with the possible exception of those adjacent to the cortex. The discrepancy in these two accounts may be due to the fact that the walls of two or three of the outer medullary layers frequently show a brownish pigmentation.

The perianths of *S. gymnostomophila* are exceedingly rare, and very few have been observed. Kaalaas emphasizes the plicate feature and states that the mouth is contracted and finely dentate. A few of the specimens from Wisconsin show badly weathered perianths, agreeing in most respects with the published descriptions but showing short-ciliate, rather than dentate, mouths. According to Buch plicate perianths can occasionally be found in the section *Curtae* of the subgenus *Euscapania*, although in most species of this group the perianths definitely conform to the *Scapania* type. He thinks, therefore, that Kaalaas attached too much importance to this feature when he excluded *S. gymnostomophila* from *Scapania*.

The golden-brown, two-celled gemmae of *S. gymnostomophila*, with their thickened walls, are very helpful in distinguishing the species.

In most cases they are distinctly pointed at both ends and commonly show a fusiform outline, although deviations from this form are to be expected. In *S. curta* and its allies, with which the present species has sometimes been confused, the gemmae are usually green, except where exposure to direct sunlight produces a reddish pigmentation.

2. Scapania apiculata Spruce, Hepat. Pyrenaicae Exsic. 15. 1847; Ann. & Mag. Nat. Hist. II. **4:** 106. 1849.

On logs, often associated with other bryophytes.

Maine: Round Mountain, Franklin County, 1912 (*Miss Lorenz*), listed in Rhodora **14:** 224. 1912; Caribou, 1913 (*A. W. E.*); Megantic Preserve, Franklin County, 1916 (*Miss Lorenz*).

New Hampshire: Chocorua, 1906 (*Farlow*), listed in Rhodora **9:** 71. 1907; Flume and Franconia Notch, 1908 (*Miss Lorenz et al.*), listed by Miss Lorenz in Bryologist **11:** 114. 1908; Waterville, 1911 (*A. W. E.*); King's Ravine, Randolph, and Columbia, 1917 (*A. W. E.*).

The following North American stations outside New England may also be cited:—Manitoba: Manitoba House, 1881 (*Macoun*), listed in Rhodora **9:** 71. 1907. New York: North Elba, 1898 (*Peck*), listed by Peck in Bul. N. Y. State Mus. **6:** 178. 1899. Wisconsin: St. Louis Bay, Superior, 1905 (*Conklin*); Copper Creek, 1909 (*Conklin*); Wentworth, Douglas County, 1910 (*Conklin*); Stone's Bridge, Brule River, Douglas County, 1916 (*Conklin*). Minnesota: Spirit Lake, Duluth, 1907 (*Conklin*); Lutsen, Cook County, 1911 (*Conklin*). The specimens from Wisconsin and Minnesota, collected prior to 1914, have been listed by Conklin in Trans. Wisconsin Acad. **18:** 1004, 1005. 1914. So far as known *S. apiculata* is confined to old logs. It has a wide distribution in Europe and northern Asia, although far from abundant throughout the greater part of its range.

The writer has already published a short account of this distinct species (**5,** p. 71); but a summary of its more important features, including certain peculiarities brought out for the first time in Buch's description, may be of interest. The stem, as in all the *Scapaniae*, shows a differentiation into a cortex composed of small thick-walled cells and a medulla composed of larger thin-walled cells. The cortical cells, which are in one or two layers, are strongly flattened, much as in *S. gymnostomophila*, and their walls are pigmented with brown. According to Buch's measurements these cells are only 7–13 μ in radial width and thus stand in sharp contrast to the medullary cells, which are 27–43 μ in diameter.

Other distinctive features of *S. apiculata* are found in the leaves and in the mouth of the perianth. In the leaves both lobes are sharp-pointed, and the points consist either of a single cell or of a cell-row two or three cells long. The dorsal lobe is somewhat smaller

than the ventral and, in some cases, spreads away from it in a squarrose manner. The margins are usually entire but occasionally show one or two indistinct teeth. The leaf-cells are characterized by their large and conspicuous trigones, which are present even in the marginal cells, and by their verruculose or striolate-verruculose cuticle. The trigones in most cases have convex sides and may be coalescent. In each leaf-cell two to six fat-bodies are present and may persist even in herbarium material. These fat-bodies are much smaller than those of *S. gymnostomophila* and present a granular appearance. The mouth of the perianth is normally entire, although in rare instances a marginal cell may project as a vague crenulation or denticulation.

Other characters of importance are derived from the gemmiparous leaves and branches. Buch was the first to show that these structures are highly specialized. The leaves, for example, toward the tip of the branch become gradually rounder, and their lobes become gradually shorter until the sinus between them completely disappears. These leaves, instead of being keeled, are closely appressed to the axis; and the gemmiparous branches, the growth of which is sooner or later limited, thus acquire a flagelliform appearance. The unicellular gemmae of *S. apiculata* are brown in color and broadly elliptical in form. Flagelliform branches of the type just described, with specialized gemmiparous leaves, are apparently confined, in *Scapania*, to the section *Apiculatae*. Similar branches are found, however, in two species of the allied genus *Scapaniella:* the European *S. vexata* (Massal.) Buch and the North American *S. glaucocephala*.

3. Scapania curta (Mart.) Dumort. Recueil d'Obs. sur les Jung. 14. 1835. *Jungermannia curta* Mart. Fl. Crypt. Erlangensis 148. *pl. 4, f. 24.* 1817. *J. rosacea* Corda in Sturm, Deutschl. Fl. II. **23**: 96. *pl. 29.* 1832. *Scapania rosacea* Nees in G. L. & N. Syn. Hep. 71. 1844.

On soil, sometimes in exposed localities and often accompanied by other bryophytes. Most of the records for *S. curta* and the two following species are based on Buch's determinations.

Maine: St. John River, between St. John Pond and mouth of the Allegash River, 1917 (*Nichols*); determination somewhat doubtful, In his monograph (**4**, p. 61) Buch lists two specimens from Maine. without giving more definite data.

New Hampshire: shore of Peabody River, near Gorham, 1897 (*Farlow*); Jackson, 1902 (*A. W. E.*). Both of these stations are listed in Rhodora **4**: 212. 1902.

The following stations from other parts of North America may likewise be listed:—British Columbia: Asulkan Valley, 1908 (*Brink-*

man). WISCONSIN: near Cornucopia, Bayfield County, 1907 (*Conklin*). CALIFORNIA: Tuolumne Meadows, 1928 (*Mrs. Sutliffe*): Yosemite Park, 1928 (*Mrs. Sutliffe*). Buch lists the species also from Minnesota, but there are no specimens from the state in the Yale Herbarium. In Europe and northern Asia *S. curta* is widely distributed.

In the section *Curtae*, as defined by Buch, the relatively small plants vary in color from green to brownish or reddish. In the stems the difference in size between the cortical and medullary cells is less pronounced than in the *Apiculatae*. The cortex is composed of one or two layers of cells with thick walls usually pigmented with brown, but the cells are scarcely flattened and usually appear isodiametric in cross-section. The leaf-lobes are rounded or abruptly short-pointed at the apex, and neither lobe arches across the stem. The production of gemmae, which are usually developed in abundance, tends to inhibit the growth of the gemmiparous leaves, but the gemmiparous branches do not acquire a flagelliform appearance.

The *Curtae* have been the cause of much confusion to hepaticologists, and divergent views have been held regarding the identity of *S. curta* and its range of variation. In 1916 Buch (**2**) emphasized the fact that the leaves of the species, as understood by most authors, showed two distinct types of cell-structure. In the first type one or more rows of marginal cells have uniformly thickened walls, whereas the interior cells have trigones; in the second type all the cells, including the marginal, have trigones. Buch decided that the species was too broadly defined and that it might better be treated as a group of related species. In carrying out this idea he segregated *S. mucronata* and *S. lingulata* from the old *S. curta* as new species. Buch, however, was not the first to distinguish the two types of cell-structure in the leaves of *S. curta*. This had already been done by Lindberg as early as 1889 (**9**, p. 31). Lindberg, in fact, had divided *S. curta*, as ordinarily understood, into two species on the basis of this distinction. Plants showing the first type he referred to *Martinellia rosacea* (Corda) Lindb. & Arnell and retained the name *M. curta* (Mart.) Lindb. & Arnell for plants showing the second type. From the study of the specimens in the Lindberg Herbarium Buch concluded that Lindberg's *M. rosacea* really represented the true *Scapania curta* and that his *M. curta* included *S. mucronata*, *S. lingulata* and several other species (see **4**, p. 55).

Buch divides the section *Curtae* into the two subsections *Marginatae* and *Immarginatae*. The first of these, which includes *S. curta* as now

restricted, is based on plants having leaves with a border, in other words on leaves showing the first type of cell-structure; the second, which includes *S. mucronata* and *S. lingulata*, on plants having leaves with the second type of cell-structure. The border in *S. curta*, as he describes it, is one to four cells wide. On the outside the cell-walls are uniformly thickened but toward the inside the boundary of the border is vague, owing to the insensible gradation between the cells with uniformly thickened walls and the interior cells with trigones separated by thin cell-walls.

Aside from the bordered leaves *S. curta* is characterized by the rounded to subacute apices of the lobes, which are either entire or sparingly and irregularly toothed; by the denticulate mouth of the perianth with teeth one to three cells long; and by the green, two-celled, elliptical gemmae. The plants are usually green but may assume a reddish or brownish color in direct sunlight. The cortex is green in shaded localities but sometimes shows a reddish pigmentation even when the leaves remain green. In extreme cases the cortex becomes dark reddish brown. The trigones of the leaf-cells in the interior of the lobes have straight or slightly convex sides, but the cavities never present a stellate appearance.

The species is exceedingly variable and readily responds to changes in the environment. In mod. *mesoderma* and mod. *pachyderma* the leaf-borders are distinct, but in mod. *leptoderma* the borders may not be differentiated at all. This modification often occurs in plants with small and distant leaves, constituting mod. *parvifolia-leptoderma-laxifolia* of Buch; and similar modifications may arise in *Scapania irrigua* (Nees) Dumort., which resemble those of *S. curta* very markedly. It is often difficult, in fact, especially in dried material, to determine these leptodermous modifications positively.

4. Scapania mucronata Buch, Medd. Soc. F. et Fl. Fenn. **42**: 91. *f. 6, 9.* 1916; Comm. Biol. Soc. Sci. Fenn. **3**[1]: 63. *f. 14.* 1928. *Martinellia mucronata* Arnell & Jensen, Svensk Bot. Tidskr. **12**: 309. 1918.

On soil, decayed logs, or shaded rocks, often accompanied by other bryophytes.

Maine: Eastport, 1911 (*A. W. E.*); Fort Kent, 1913 (*A. W. E.*).

New Hampshire: Jackson, 1890 and 1898 (*A. W. E.*).

Massachusetts: Mt. Holyoke, 1903 (*Miss Lorenz*), listed as *S. curta* in Rhodora **6**: 190. 1904.

Connecticut: shore of Black Pond, Meriden, 1907 (*Miss Lorenz*), listed as *S. curta* in Rhodora **10**: 192. 1908; Mt. Carmel, Hamden, 1913 (*Miss Lorenz*); Killingly, 1926 (*Miss Lorenz*).

Buch, in his Monograph, cites the species from Vermont, but there are no specimens from this state in the Yale Herbarium.

The following stations from various other parts of North America may also be cited:—GREENLAND: Upernavik, 1834 (*Vahl*), cited by Buch; Manetsok, no date (*Warming & Holm*), also cited by Buch. ALASKA: Yakutat Bay, 1899 (*Brewer & Coe*), listed as *S. curta* in Proc. Washington Acad. **2**: 312. 1900. YUKON: Hunker Creek, 1902 (*Macoun*), listed as *S. curta* in Ottawa Nat. **17**: 23. 1903. NOVA SCOTIA: Aspy Bay, 1917 (*Nichols*), listed by Nichols as *S. curta* in Bryologist **21**: 28. 1918. BRITISH COLUMBIA: Tetachuk, 1911 (*Brinkman*), listed by Arnell as *Martinellia curta* in Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälles Handl. 23. 1922. NEW YORK: island in Chilson Lake, 1901 (*Mrs. Smith*). MICHIGAN: shore of Douglas Lake, 1920 and 1921 (*Nichols*), listed by Nichols as *S. curta* in Bryologist **25**: 47. 1922; Grand Island, Alger County, 1934 (*Nichols*), listed by Nichols in Bryologist **38**: 15. 1935. WISCONSIN: Black River, Douglas County, 1909 (*Conklin*); Bayfield County, Lake Superior, 1924 (*Conklin & Wilson*). MINNESOTA: Chester Creek Park, Duluth, 1909 (*Conklin*), distributed as *S. curta* by C. C. Haynes, Amer. Hepat. 75; Knife River, 1909; Carlton, 1909 and 1911; Lutsen, Cook County, 1911; Thompson, 1911; Thompson Gorge, St. Louis River Dells, Carlton County, 1924. OREGON: Pigeon Point, 1931 (*Miss Sanborn*), listed by Brinkman in Rept. Prov. Mus. Nat. Hist. [Victoria, B. C.] 1934: 14. The specimens from Minnesota were all collected by Conklin; several of these specimens, together with the first specimen from Wisconsin, are listed as *S. curta* by Conklin in Trans. Wisconsin Acad. **17**: 1005. 1914. The species is widely distributed in Europe and northern Asia.

It will be seen from the specimens cited that many of the North American records for *S. curta* have been transferred to *S. mucronata*. In view of the wide range of variation hitherto assigned to *S. curta*, it is obvious that published records for the species ought not to be accepted without a re-examination of the specimens upon which they were based.

When Buch proposed *S. mucronata* as a new species he described the trigones of the leaf-cells as unusually large and stated that the cell-cavities, in consequence, were distinctly stellate. Arnell, in recognizing the validity of *S. mucronata* (**1**, p. 29), under the name *Martinellia mucronata*, took exception to this statement. According to his account the cell-cavities, in many cases, are rounded, and the trigones are not especially large. In his monograph (**4**, p. 66) Buch admits the force of Arnell's criticism and finds that the cavities are rounded in the relatively frequent mod. *mesoderma*. He states, however, that stellate cavities are present in the relatively rare mod. *pachyderma*, which grows almost exclusively on rotten logs. All the

North American specimens examined by the writer show trigones clearly, even in the marginal leaf-cells. In some cases the sides of the trigones are definitely convex and project slightly into the cell-cavities, thus producing a somewhat stellate appearance; but this appearance is unusual, since most of the trigones observed have straight or slightly concave sides. These specimens, therefore, for the most part, represent mod. *leptoderma*.

In distinguishing *S. mucronata* from the other representatives of the *Immarginatae* Buch emphasizes the following features: the relatively small size of the marginal leaf-cells, which measure only 13–20 μ in width; the usual absence of teeth along the margins; the obovate ventral lobes, usually rounded with a sharp apical tooth, but sometimes more gradually pointed; the presence of an apical tooth on the dorsal lobes; the lobed and fimbriate mouth of the perianth, which may be either plicate or wholly destitute of supplementary folds; the elliptical, oval, or narrowly triangular, two-celled gemmae, varying in color from green to reddish.

The apical teeth of the lobes, according to his account, consist of a row one to three cells long, and he implies that these teeth are constantly present. In the European material examined by the writer this seems to be literally the case, except in very rare instances, although some of the one-celled teeth project very slightly. In several of the North American specimens, however, the ventral lobes, to a greater or less extent, are broadly rounded at the apex and show no signs of apical teeth. This might indicate that *S. mucronata* was more variable than the descriptions imply or that the specimens in question were incorrectly determined.

At first thought the closely related *S. scandica* (Arnell & Buch) Macvicar (see Buch, **4**, p. 73) comes to mind. This species, which is widely distributed in Europe, is known also from Iceland and Greenland and is therefore to be expected in continental North America. It agrees with *S. mucronata* in several important respects but differs in its usually rounded ventral lobes, in the smaller trigones of its leaf-cells, and in the entire or very sparingly denticulate mouth of its perianth. Unfortunately the North American specimens with rounded lobes are mostly sterile. A single perianth, however, was detected in the material from Mt. Carmel, Connecticut, in which rounded ventral lobes are much in evidence, and this perianth is distinctly fimbriate at the mouth. This particular material, therefore, cannot be referred to *S. scandica*, and it seems best to retain it in *S. mucronata*, at least

until the range of variation in this species is better understood. The sterile specimens with rounded ventral lobes are likewise retained in *S. mucronata*, since they agree in all essential respects with the Mt. Carmel specimens.

Arnell, in his study of European and Siberian material, apparently met with similar difficulties (**1**, p. 30). In assigning a long series of specimens to *Martinellia mucronata* he states that he is not quite convinced that all of these specimens belong to one and the same species, since the material is not homogeneous. He prophesies, in fact, that the very critical *curta*-group may show itself unexpectedly rich in distinguishable species. The time is hardly ripe, however, to make further segregations, and a supposed new species in the group should be subjected to careful culture-methods before it is definitely proposed.

Attention has already been called to mod. *leptoderma* of *S. curta*, in which the distinctive leaf-borders of the *Curtae* are not differentiated. The mod. *parvifolia-laxifolia*, with which the leptodermous condition is often associated, represents, according to Buch (**3**,) a direct response to a diminished light supply, which casuses a lengthening of the internodes and, as a result, the separation of the leaves. In *S. mucronata*, *S. scandica*, and *S. lingulata*, however, a diminished light supply has little or no effect on the length of the internodes, although it does cause a diminution in the size of the leaves. These species, therefore may occur as mod. *parvifolia-densifolia* but not as mod. *parvifolia-laxifolia*. On account of these differences in response, which are to be regarded as specific in character, leptodermous modifications of *S. curta* with scattered leaves can, in many cases, be easily distinguished from leptodermous modifications of the *Immarginatae*, with which they might otherwise be easily confused.

5. SCAPANIA LINGULATA Buch, Medd. Soc. F. et Fl. Fenn. **42**: 92. *f. 1–3.* 1916; Comm. Biol. Soc. Sci. Fenn. **3**[1]: 69. *f. 15.* 1928. *Martinellia lingulata* Arnell, Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälles Handl. 31. 1922.

On rocks or exposed soil, rarely on rotten logs, caespitose or accompanied by other bryophytes.

MAINE: Thunder Hole, Mt. Desert, 1920 (*Miss Lorenz*), listed by Miss Lorenz as *S. curta* in Rhodora **26**: 6. 1924; Miss Lorenz listed *S. curta* also from a second Mt. Desert station, but her specimens (according to Buch) are depauperate and hardly referable to any definite species.

Buch cites *S. lingulata* from Amaralik, Greenland, where it was

found in 1830 by Vahl, but no other North American stations are known at the present time. The species is widely distributed in Finland, Sweden, and Norway and has been found once in Iceland. Although it is still unknown from Siberia, Buch thinks that it is probably circumpolar in its range.

The relationship between *S. mucronata* and *S. lingulata* is very close, and it is not surprising that the earlier writers failed to separate them. As distinguishing characters of the latter species Buch points out the following: the slightly larger size; the lingulate, rather than obovate, ventral lobes; the somewhat larger leaf-cells, which measure 20–26 μ along the margin, instead of only 14–20 μ as in *S. mucronata;* and the usual presence of scattered unicellular teeth, which are in the form of equilateral triangles.

In Buch's revised description of *S. lingulata* (**4**, p. 69) he states that the ventral leaf-lobes may be either rounded at the apex with an apiculum consisting usually of a single cell, or else more gradually sharp-pointed, and adds that the latter condition is more frequent in poorly developed plants. This account implies that the lobes are always pointed. The writer, from an examination of specimens from Finland and Sweden, as well as from Mt. Desert, finds that the ventral lobes, in the majority of cases, conform to Buch's description. In a few cases, however, the lobes are rounded but without apicula, and similar lobes are represented in one of Buch's figures (**4**, *f. 15*[3]).

Although the lobes of an occasional leaf may be entire throughout, marginal teeth are present in most cases and vary in number from one to seven on the ventral lobes and from one to five on the dorsal lobes. When a single tooth is present it usually marks the apex. The perianths of *S. lingulata* are lobed and ciliate at the mouth, and the green or reddish two-celled gemmae are oval, elliptical, or triangular. The perianths and gemmae, therefore, are much like those of *S. mucronata.*

Literature cited

1. **Arnell, H. W.** Die schwedischen Arten der Gattungen *Diplophyllum* und *Martinellia.* Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälles Handl. 1–80. 1922.

2. **Buch, H.** Studien über die Scapanien Fenno-Scandias. I. *Scapania curta*-Gruppe (vorläufige Mitteilung). Medd. Soc. F. et Fl. Fennica **42:** 85–96. *f. 1–12.*

3. ————. Die Scapanien Nordeuropas und Siberiens. I. Soc. Sci. Fennica Comm. Biol. **1**[4]**:** 1–21. *f. 1–11.* 1922.

4. ————. Die Scapanien Nordeuropas und Siberiens. II. Systematischer Teil. Ibid. **3**[1]**:** 1–173. *f. 1–39.* 1928.

5. **Evans, A. W.** Notes on New England Hepaticae,—V. Rhodora **9:** 56–60, 65–73. *pl. 73.* 1907.

6. ————. Notes on New England Hepaticae,—XI. Rhodora **16:** 62–76. 1914.

7. ———. Three species of *Scapania* from western North America. Bul. Torrey Bot. Club **57:** 87–112. *f. 1–8.* 1930.
8. **Kaalaas, B.** Beiträge zur Lebermoosflora Norwegens. Vidensk. Skrift. I. Math.-naturv. Kl. **1898[9]:** 1–28. *f. 1–7.*
9. **Lindberg, S. O., and Arnell, H. W.** Musci Asiae Borealis. Erster Theil. Lebermoose. Kongl. Svenska Vetensk.-Akad. Handl. **23[5]:** 1–69. 1889.

POLLINATION OF THE ERICACEAE: IV. LEDUM AND PYROLA

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LEDUM GROENLANDICUM Oeder

LEDUM GROENLANDICUM Oeder, Labrador tea, is occasionally abundant over small areas in damp acid soils in southern Maine. It is an upright evergreen shrub, from 3 to 10 dm. tall, with thick, oblong leaves, strongly revolute at the margins, which are densely rusty-woolly beneath, a provision, according to Kerner, against too rapid transpiration.

The small white flowers, which are slightly aromatic, are in terminal umbel-like clusters of ten to twenty-five flowers each, with two or three clusters at the end of each branch. The flowers are from 1.2 to 1.5 cm. broad. The stamens are usually five alternating with the petals, but frequently there are six, and in one instance there were eight. As *L. palustre* has normally ten stamens, the occurrence of extra stamens opposite the petals in *L. groenlandicum* may be a case of reversion.

The filaments are white, hairy at base, with yellowish anthers which open by terminal pores. The pollen is yellow and in tetrads. In mature buds 5 mm. long (FIG. 1, A) the stamens are 7 to 8 mm. long, their filaments bowed under tension, and spring or move upward when the petals are separated. The anther-pores open in the bud and pollen grains may be observed around these openings and on the stigma with which the anthers are in contact at this stage. It is probable that self-pollination occurs frequently in the bud. The flowers are nearly homogamous though showing a slight tendency to become protandrous.

The green capitate stigma, which bears five very small tubercles, remains persistent after the pollen has been shed. The ovary is likewise green and covered densely with short glandular hairs. Nectar is secreted sparingly by a green disc at the base of the ovary, where it is partially protected by the hairs on the filaments and ovary. It